If You Stay, It Might Be Easier:

Switch Costs from Comprehension to Production in a Joint Switching Task

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Abstract

Switching language is costly for bilingual speakers and listeners, suggesting that language control is effortful in both modalities. But are the mechanisms underlying language control similar across modalities? In this study, we attempted to answer this question by testing whether bilingual speakers incur a cost when switching to a different language than the one just used by their interlocutor. Pairs of unbalanced Dutch (L1) – English (L2) bilinguals took turns naming pictures in a pure Dutch, a pure English, and a mixed-language block. In the mixed block, one participant (Switching Participant) voluntarily switched between Dutch and English, whereas the other (Non-Switching Participant) named all pictures in Dutch. Within the mixed block, the Non-Switching participant took longer to name pictures when the Switching participant's response on the preceding trial had been in English rather than Dutch, and this local switch cost was larger the more the Non-Switching participant was proficient in English. Additionally, there was strong cross-person item-level interference: The Non-Switching participant named pictures more slowly in Dutch if the Switching participant had previously named those same pictures in English rather than Dutch. These findings indicate that comprehension of utterances produced by another speaker in L2 makes subsequent production of L1 utterances more costly. We interpret this as evidence that language control mechanisms are shared between comprehension and production, and specifically that bottom-up factors have a considerable influence on language selection processes in both modalities.

Keywords: voluntary language switching; joint task; comprehension; production.

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Bilinguals often switch between their languages, especially during informal conversations with other bilinguals (e.g., Grosjean, 2001). However, switching language leads to slower responses in laboratory tasks, both when bilinguals produce a switch (e.g., Meuter & Allport, 1999) and when they comprehend a switch (e.g., Thomas & Allport, 2000). Showing that language switches are costly to process in comprehension and to execute in production is relevant for theories of bilingual dialogue since bilingual interlocutors tend to switch between their shared languages within their respective turns (e.g., Grosjean, 2001). But furthermore, in some bilingual conversations, each interlocutor consistently uses only one language (normally her first language, L1), so that switches occur *between* turns (if the two bilinguals have different L1's). Thus, bilinguals may also be confronted with switches from comprehension (of their interlocutor's utterance) to production (of their own utterance).

The goal of the present study was to investigate whether comprehension of utterances produced by another speaker in one's second language (L2) makes subsequent production of L1 utterances more costly. As we explain below, the occurrence of cross-person switch costs is compatible with theories of bilingual lexical selection that assume shared language control mechanisms between modalities, but it is not predicted by theories that do not make this assumption.

Switch Costs in Production, Comprehension, and across Modalities

In production, switch costs have been extensively studied using cued switching paradigms (e.g., Meuter & Allport, 1999), where bilingual speakers are cued to name pictures in either their L1 or their L2. In pure language blocks, they consistently use only one of their languages, while in mixed blocks cues for each language are randomly interleaved, leading to a sequence of stay (e.g., L1-L1 or L2-L2) or switch (e.g., L2-L1 or L1-L2) trials. Usually, switch trials show longer naming times than stay trials in mixed blocks (i.e., a local switch cost; e.g., Meuter & Allport, 1999; Costa & Santesteban, 2004). Additionally, bilinguals take longer to name pictures on *stay trials* within mixed blocks than in pure blocks (e.g., Hernandez & Kohnert, 1999). We will refer to this as a global switch cost (Gollan & Ferreira, 2009).

What are the mechanisms underlying local and global switch costs? According to one interpretation, a bilingual's languages compete for selection on any given naming trial (see Kroll, Bobb, Misra, & Guo, 2008 for a review). Therefore, bilinguals need to inhibit the non-target language (e.g., Philipp & Koch, 2009). This view is supported by the finding that local switch costs in production are larger when (unbalanced) bilinguals switch to their L1 than when they switch to their L2 (e.g., Meuter & Allport, 1999; but note that some studies reported symmetric local switch costs in balanced bilinguals; e.g., Costa & Santesteban, 2004). L1 lexical items have a higher resting activation level than L2 items. Therefore, correctly selecting an L2 item requires greater inhibition (of L1) than has to be applied (to L2) to correctly select an L1 lexical item; when bilinguals switch back to L1 this results in a larger switch cost because a greater level of inhibition must be overcome. Additionally, reversed language dominance effects (i.e., longer naming times for L1 than for L2 in mixed blocks; e.g., Meuter & Allport, 1999; Costa & Santesteban, 2004) suggest strong inhibition of L1 when bilinguals are mixing languages.

In summary, theories of language switching in production have, perhaps unsurprisingly, emphasized the role of top-down control in language selection, in particular with regard to top-down inhibition of the non-target language. However, switch costs also occur in comprehension (e.g., Macnamara & Kushnir, 1971; Altarriba, Kroll, Sholl, & Rayner, 1996, Experiment 1; Thomas & Allport, 2000; Grainger & Beauvillain, 1987; Soares & Grosjean, 1984), and enhanced negativities in ERPs have been associated with language switches, both in response to single words (e.g., enhanced N250 for switches to L2 and enhanced N400 for switches to L1, Chauncey, Grainger, & Holcomb, 2008), and during sentence comprehension (e.g., enhanced N400, Proverbio, Leoni, & Zani, 2004).

It is unclear whether local switch costs in comprehension are larger when switching to L1 (e.g., Jackson, Swainson, Mullin, Cunnington, & Jackson, 2004), when switching to L2 (e.g., Grainger & Beauvillain, 1987; Proverbio et al., 2004), or symmetric (e.g., Macizo, Bajo, & Paolieri, 2012). However, the very existence of switch costs in comprehension indicates that bottom-up activation of linguistic representations in one language interferes with subsequent activation of linguistic representations in the other language; therefore, it is clear that bottom-up factors must also have some role in language selection, in addition to top-down factors.

The Bilingual Interactive Activation (BIA) model (Van Heuven, Dijkstra, & Grainger, 1998) can accommodate both types of factors. It assumes that lexical items from a bilingual's languages are integrated into a single interactive lexicon. Additionally, lexical entries receive excitatory connections from a node representing the language they belong to, and inhibitory connections from nodes representing other languages. Such language nodes can be activated bottom-up (i.e., by exogenous factors, like comprehending an input word in a given language, or by language-related contextual information) or top-down (i.e., by endogenous factors, like the intention to speak in a given language; see Grainger, Midgley, & Holcomb, 2010). In this way, the model can explain the occurrence of switch costs both in comprehension and in production, and also account for the role of inhibition in production. Importantly, since the BIA model assumes that language nodes are modality-independent, it also makes the prediction that the activation of language nodes in comprehension will affect subsequent language selection in production. To our knowledge, the BIA model is the only model of bilingual language control that explicitly makes this assumption.

Various findings support this assumption. Altarriba et al. (1996, Experiment 2) asked Spanish-English bilinguals to read sentences silently, until they encountered a target word (presented in capital letters), which they had to read aloud. Participants took longer to name Spanish than English target words in an English sentence context, but because naming words involves comprehension as well as production processes, this study does not provide conclusive evidence for switch costs from comprehension to production.

More compellingly, language choices in comprehension can affect language choices in production. Kootstra, Van Hell, and Dijkstra (2010; 2012) showed that perceiving someone else switch language at a particular point in the sentence affected the location where a speaker would next switch herself. However, this study only looked at off-line measures (i.e., whether interlocutors made similar choices, not how long it took them to make such choices). Therefore, it cannot provide evidence that activation of a language node in comprehension affects the time it takes to select the same language node during subsequent production.

Most importantly, a recent study (Peeters, Runnqvist, Bertrand, & Grainger, 2014) found that reading an L2 (English) word (as part of a language decision or semantic categorization task) led to a switch cost when subsequently naming a picture in L1 (French), even though speakers named all the pictures in a block in L1. There was no switch cost from L1 comprehension to L2 production. According to the authors, comprehending words in L2 automatically raised the activation level of the L2 language node, which in turn inhibited the L1 language node and made selection of L1 more difficult on the subsequent naming trial. This study therefore provides direct support for the assumption of the BIA model that language nodes are shared between comprehension and production.

However, Peeters et al. (2014) showed comprehension to production switch costs using a paradigm in which participants performed an explicit task on input words. The authors assume that comprehension of input words activates language nodes automatically (i.e., it operates as an exogenous factor, in BIA's terminology). However, because participants had to perform a task on input words, top-down inhibition might have been sent to the node representing the non-target language during the comprehension task, so that this node would interfere less with lexical access in the target language, and performance would be facilitated. This interpretation is consistent with their finding that switch costs were more pronounced when switching from L2 comprehension to L1 production, which suggests that L1 lexical representations had to be strongly inhibited during L2 comprehension. If, on the contrary, bottom-up activation of representations was the only factor responsible for switch costs, we would have expected stronger switch costs from L1 comprehension to L2 production, because in BIA L1 words activate the L1 language node more strongly than L2 words do the L2 language node (Grainger et al., 2010; p. 72).

In summary, it is possible that Peeters et al. (2014) observed comprehension to production switch costs because of the specific requirements of their task. As a result, it is still an open question whether passive comprehension of a word in one language can lead to switch costs when producing another word in a different language. The BIA model predicts switch costs from passive comprehension to production because language nodes are shared between comprehension and production and can be activated by both bottom-up and top-down factors.

However, it is possible that switch costs from passive comprehension to production do not occur. The reason is that top-down control (endogeneous factors in BIA) might take precedence over bottom-up activation in determining language selection during production, so that passively comprehending words in one language cannot affect subsequent production of words in another. As discussed above, Peeters et al.'s findings are compatible with this view, as their participants might have exerted inhibition of the non-target language node to facilitate processing of input words. If that was the case, the cross-modality switch costs they observed would not be attributable to bottom-up factors affecting language selection during production at all, but rather would indicate that top-down factors can even take precedence during comprehension (see Macizo, Bajo, & Martin, 2010 for direct evidence that non-target language inhibition occurs during comprehension when participants are performing a task on input words).

To the contrary, if bottom-up activation of a language node can affect selection of another language node alongside top-down factors, then switch costs from passive comprehension to production should be observed even if the speaker never switches in production *and* is not assigned any task on the input words. In order to provide an empirical test for these contrasting hypotheses, we turned to a joint language switching task. A major issue for studies of language comprehension is how to ensure that participants maintain attention to the stimuli and process them deeply enough. A challenge for the present study was to achieve this without assigning participants any explicit task for the input words. Our solution was to test two blingual speakers together, as described in the next section.

The Present Study

Both participants in our joint task were Dutch (L1)-English (L2) bilinguals. In the pure blocks, they took turns in naming pictures in the prescribed language (L1 or L2). In the mixed block, they had different roles, while they also alternated in naming pictures. One participant never switched, naming all pictures in L1 (Non-Switching participant). Their partner, instead, was instructed to switch, voluntarily, between their L1 and L2 (Switching participant). We had our Switching participants switch voluntarily rather than in response to cues for two reasons. First, switching voluntarily more closely resembles the conditions under which bilinguals experience switches outside the laboratory. Second, because we wanted to emphasize the joint nature of the task, we had the two bilinguals sit next to one another and look at the same computer screen. Language cues would have therefore been visible to both participants, allowing the Non-Switching participant to prepare for a switch. But since longer preparation times lead to reduced switch costs in language production (Declerck, Philipp, & Koch, 2013), we decided to avoid the use of cues (note that the language in which a word would appear was not pre-cued in Peeters et al., 2014).

Neither participant was assigned any particular task with regard to their partner's responses. However, successfully taking turns (i.e., without overlapping) likely requires that participants attend to and monitor their partner's responses. Note that we did not test a condition in which the Non-Switching participant named all pictures in L2. We did so mainly because of practical reasons[1]. But importantly, according to BIA switch costs due to bottom-up factors should be larger from L1 to L2. Because we only test for the presence of switch costs from L2 to L1, this design choice might, if anything, disfavour our prediction that switch costs from passive comprehension to production should occur.

An analysis of the *Non-Switching participant*s provided the decisive test. If top-down factors dominate language selection, then the language chosen by the Switching participant on the preceding trial should make no difference to how rapidly the Non-Switching participant names pictures in his or her L1. In the context of a joint switching task like ours, we call this view, which predicts no cross-person (cross-modality) switch costs, the *within-person selection* view. We term the alternative view, which predicts the occurrence of such switch costs, the *cross-person interference* view. If the cross-person interference view is correct, speakers who never switch themselves should experience switch costs from comprehension of their partner's productions, despite the fact that they are not given any task to perform on their partner's productions. In other words, Non-Switching participants should be slower naming in L1 when they heard their partner using L2 on the previous trial than after they have heard their partner using L1 (i.e., a local switch cost). Further, L1 naming times on stay trials in the mixed block should be longer than L1 naming times in the pure L1 block (i.e., a global switch cost) for Non-Switching participants. If the within-

[1] First, because of multiple requirements (e.g., English and Dutch names could not be cognates; see Materials for a full list), we were somewhat limited in our choice of materials. Second, we expected Non-Switching participants to be more prone to errors when naming in English, and Switching participants to be more likely to stay in Dutch than to switch to English. The combination of these two factors could have led to considerable data loss particularly in the cell of the design corresponding to L2-L2 trials (i.e., trials in which the Non-Switching participant produced an English name, preceded by an English response by the Switching participant). Therefore, we decided to leave out the condition in which Non-Switching participants would name all pictures in L2.

person selection view is correct, Non-Switching participants should experience no switch costs (neither local nor global).

So far, we have focussed on the assumption of the cross-person interference view that language nodes are shared between modalities. We have not yet considered the possibility that linguistic representations for individual items might also be shared between production and comprehension. Several accounts assume such item-level sharing, at least for conceptual and lexical representations (Levelt, Roelofs, & Meyer, 1999; Pickering & Garrod, 2004; and, with regard to the bilingual lexicon in particular, Hartsuiker, Pickering, & Veltkamp, 2004). If bottom-up factors can affect language selection in production, as predicted by the cross-person interference view, and in addition conceptual representations for individual items are shared between comprehension and production, then we predicted that the Non-Switching participant would take longer to retrieve the Dutch names specifically of those pictures that had been previously named in English by the Switching participant (during the same session, but not necessarily on the immediately preceding trial).

We tested this prediction by analysing the Non-Switching participant's naming latency for a given picture in the second half of the experimental session as a function of the language the Switching participant had chosen for the same picture in the first half of the session. For example, if the Switching participant named the current picture (e.g., of a bird) in English in the first half of the session, comprehending the English name (*bird*) should have strengthened the connection between the English language node and the concept BIRD/VOGEL in the Non-Switching participant's mental lexicon. As a consequence, when the Non-Switching participant accesses the concept BIRD/VOGEL again (during the second half of the session), with the intention of selecting the Dutch word *vogel*, this participant should experience some interference, because of activation spreading from the concept BIRD/VOGEL to the English language node; less interference should occur when the Switching participant chose the Dutch name *vogel* in the first half of the session.

Note that the within-person selection view makes no such prediction, because it assumes that top-down inihibition of the non-target language (English) during production should take precedence over bottom-up activation of the English node (due to conceptual processing of the picture in this case).

Additionally, an analysis of the *Switching participants* allowed us to address two alternative interpretations of the predicted cross-person switch costs for Non-Switching participants. The first alternative interpretation for cross-person local switch costs is what we term the "unpredictability" hypothesis. One might argue that speakers of Dutch will be slower after their partner used English than after their partner used Dutch simply because their partner is overall less likely to use English (i.e., English is less expected and more surprising). This might be a particularly relevant factor in conversations between unbalanced bilinguals who share the same L1, like our participants. Moreover, given previous studies about voluntary language switching in production (Gollan & Ferreira, 2009, Experiment 1; Gollan, Kleinman, & Wierenga, 2014, Experiments 1 and 2), we expected our bilinguals to switch quite infrequently (about 25% of the time), and to mostly exhibit a preference to stay in L1. To explore whether switch costs for Non-Switching participants depended at all on how likely their partners were to switch to or to use English, we computed correlations between the Switching participant switch rate, and number of English responses, and the Non-Switching participant local cost. Further, we tested whether the language chosen by the Switching participant on his or her second-to-last trial would modulate the magnitude of the local switch cost.

The second alternative interpretation for cross-person switch costs (both local and global) is that Non-Switching participants might be adapating, on a trial-by-trial basis, to the response speed of their partners (the adaptation hypothesis). If Switching participants happened to be slower naming in L2 than in L1 within the mixed block, then evidence that Non-Switching participants are slower after the Switching participant has used L2 than after he or she has used L1 could be explained by such adaptation in response timing. But importantly, and again based on Gollan et al.'s studies, we expected Switching participants to actually be slower naming in L1 than in L2 within the mixed block (that is, they should show reversed language dominance). This prediction, if confirmed, would therefore rule out this alternative explanation for the expected local switch costs. Note that Gollan et al. also found a global switch cost for L1 in their switching participants, and if this effect is replicated, any global costs for Non-Switching participants should be interpreted carefully.

To summarize our predictions for Non-Switching participants, if the cross-person interference view is correct, we predict a local switch cost (from passive comprehension of L2 to L1 production), and also a global switch cost (i.e., production in L1 on stay trials is more difficult when comprehending another bilingual who sometimes uses L2 than in a pure L1 context). The within-person selection view, instead, predicts neither local nor global switch costs for the Non-Switching participants. In addition, if not just language nodes, but also conceptual representations are shared between comprehension and production, the cross-interference view further predicts that Non-Switching participants should take longer to retrieve the Dutch names of pictures for which their partner has previously used the English name, therefore leading to item-level interference effects; no such effects are expected if the within-person view is correct. Finally, if local switch costs for Non-Switching participants are present, further analyses of the Switching participants' performance are planned to rule out alternative explanations in terms of "unpredictability" of a switch to English (the unpredictability hypothesis), or adaptation to the Switching participants' speed of response (the adaptation hypothesis).

Method

Participants

Fifty-eight Dutch-English bilinguals, divided in 29 pairs, were either paid or received course credits for their participation. Data from two pairs were lost due to equipment malfunctioning, one pair was discarded due to the participants producing more than 50% incorrect trials in the pure English block, and two pairs were discarded because one of the participants named two pictures in a row in the Mixed language block. This left 24 pairs for scoring and analysis. Participants were students or staff members at Ghent University.

All participants were native speakers of Dutch (46 spoke a Flemish variety, and 2 spoke a variety from the Netherlands). Their language profile was determined via the Dutch version of LEAP-Q (Marian, Blumenfeld, & Kaushanskaya, 2007). Two (one Switching and one Non-Switching participant) were exposed to both Dutch and English from an early age (< 4). The others were late bilinguals (age of acquisition for English: M= 11.5 yrs, SD = 2.0 yrs). With the only exception of one of the early bilinguals (a Non-Switching participant), they all rated themselves as dominant in Dutch. All analyses reported below for Non-Switching participants were carried out excluding the data from the participant who rated herself as dominant in English; however, we opted to include all Switching participants in the analyses, including the one that was paired with the English-dominant Non-Switching participant. The two groups of participants did not differ in English spoken proficiency ($t(46) = -1.02$, $p = .31$), nor in average daily exposure to English ($t(46) = -1.49$, $p = .14$) or Dutch ($t(46) = .38$, $p = .71$; see Table 1 and Table B1 in Appendix B for additional information).

INSERT TABLE 1 ABOUT HERE

Materials

We selected 132 pictures from Severens, Lommel, Ratinckx, and Hartsuiker's (2005) Dutch picture naming norms, with the constraint that their names were not cognates (see Appendix A, Table A1). One picture (*kous – sock*), whose non-preferred Dutch name (*sok*) is a cognate of the

English name was included by mistake and discarded for the purpose of all analyses reported below[2].

From previous research, we expected Switching participants to be more likely to choose L2 (English in the present case) for high-frequency than low-frequency words (Gollan & Ferreira, 2009). For comparability with previous studies, we therefore also included a frequency manipulation. Half of the pictures had low frequency (M= 5.6 per million, min= 1, max= 16.0), and the other half had high frequency names in Dutch (M= 99.6 per million, min= 18.0, max= 900.0), (based on CELEX, Baayen, Piepenbrock, & van Rijn, 1995, as reported by Severens et al., 2005). The items were pseudo-randomly assigned to three lists, so that each list contained exactly 22 low-frequency items and 22 high-frequency items. The three lists did not differ in mean frequency (based on pair-wise t-tests, separately for high- and low-frequency sub-lists; all t's< .20; p's > .80).

Design

The two participants in a pair performed different roles (randomly assigned by tossing a coin). The Non-Switching participant was never required to switch between languages in production. The Switching participant, instead, was asked to switch in one of the conditions (see below).

Language Context (henceforth, Context) varied within-participants and within-items. In the Dutch-only context, both participants named all pictures in Dutch. In the English-only context, both participants named all pictures in English. In the Mixed context, instead, the Non-Switching participant named all pictures in Dutch (so their task was the same as in the Dutch-only context)

[2] Another item (*auto* – *car*) could also be considered a cognate, as the word *auto* is used in English in expressions like *auto parts*. However, this case is different from *kous* – *sock* because it is unlikely our participants would use *auto* as an alternative word for *car* when naming the picture of a car in English (whereas *sok* is clearly an alternative for *kous* when naming the picture of a sock in Dutch). Therefore, the analyses we report below include this item. In any case, note that removing this item from the analyses would lead to exactly the same pattern of results as reported below.

while the Switching participants could voluntarily decide, for each picture, whether to name it in Dutch or English.

Frequency varied within-participants but between-items. The assignment of lists to conditions was fully counterbalanced across participants. Each pair of participants only saw each list once. In order to collect a sufficient number of observations, each item in a list occurred twice. However, it was named only once by each participant. Presentation order was individually randomized for each pair. To prevent two identical items from being presented in immediate succession, each list was divided into two halves and items named by one participant in the first half were named by the other participant only in the second half.

Procedure

Participants were tested in pairs. They sat in front of the same computer screen (the Non-Switching participant on the left, the Switching participant on the right). We decided to familiarize the participants with the picture names to minimize data loss and encourage voluntary switches to English. During familiarization participants saw each of the 132 experimental pictures on the screen, together with their Dutch and English names, and were instructed to read both names out loud (first Dutch, then English) in unison.

After familiarization, the Non-Switching participant put on a head-mounted microphone connected to a custom-made voice-key (Duyck et al., 2008) and the voice-key was tested. The voice-key recorded onset times while the experimenter (the first author) coded the Non-Switching participants' responses online for accuracy and fluency (i.e., presence of filled pause before response onset). The Switching participant responses were recorded via a high-quality USB microphone (SE-Electronics, Hertfordshire, UK, www.seelectronics.com). An audio-file, time-locked to picture onset was automatically generated for each trial using the sound recording features of E-Prime (Version 2.0). The recording timeout was set to 2250 ms. Switching participants' responses were coded offline (by the first author) for accuracy and fluency, and their speech onset times were measured manually using Audacity software (Version 1.2.5). To reduce data loss, in case of voice-key failures, the Non-Switching participant's onset times were also manually determined[3] (the Non-Switching participant's responses were recorded through the same USB microphone).

The three contexts were administered in separate blocks. Testing order was counterbalanced across pairs. Instructions for each context were given just before testing the corresponding block, in English (by the first author). In the Mixed context, we asked Switching participants to use the name that came to mind more quickly (as in Gollan & Ferreira's Experiment 1), but also encouraged them to "name at least some of the pictures in English".

Throughout the entire experiment, the participants took turns in naming pictures, with the Non-Switching participant always naming the odd items and the Switching participant always naming the even items in the sequence. Therefore, on each trial, only one of the participants gave a response (i.e., the participants performed complementary go-nogo tasks). A trial started with a fixation cross that stayed on screen for 250 ms. To help participants track turn alternation, the fixation cross had a different colour when it was the Non-Switching participant's turn to respond than when it was the Switching participant's turn. Then the picture was presented in the centre of the screen for 800 ms. The inter-trial interval was 1000 ms. After the naming session, both participants filled in the Dutch version of the LEAP-Q (Marian et al., 2007). The entire experiment took approximately 45 minutes.

[3] According to Duyck et al. (2008), the average absolute delay between manually coded RTs and RTs measured with the kind of voice key we employed is only 5.6 ms (p. 1320). Thus, the two measures have been proved to be highly comparable.

Results

Scoring and analysis

Trials on which the participant's response was preceded by noise (e.g., laugh, cough), or the other participant was still responding to the previous trial (1.21 % in total) were discarded. Additionally, we discarded 0.13% of the trials because the participants did not respect the turn-taking instructions (they switched turns). All trials in which a participant gave no answer, a late answer (i.e., after the timeout of 2250 ms), used the wrong name, or was disfluent were coded as errors. The distribution of errors in the different conditions was analyzed using linear mixed effects models with a logistic link function. Naming latencies (for correct responses only) were analyzed using linear mixed effects models with a normal link function. All analyses were conducted in R (Version 3.0.3) using the lme4 package (Bates, Maecheler, & Dai, 2008).

For fixed effects, we report estimates, standard errors, and associated test statistics derived from the full model. The full model included all fixed effect predictors (and all interactions), random intercepts for both subjects and items, and random slopes for all factors for which it was appropriate[4] (Barr, Levy, Scheepers, & Tily, 2013), unless it was necessary to simplify the random structure to aid convergence. The models are reported in Appendix C (Tables C1-C9, which include details of which random terms were included into each model). In the text, we only report estimates, standard errors, and test statistics (t or z values) for fixed effects; |t| or |z| values greater than 2 are taken to be statistically significant with an alpha of .05; in case of values of |t| or |z| lower than 1,

[4] No by-item random slopes were included for Proficiency as different participants saw different items in different conditions.

we do not report estimates and standard errors (and these are not included in the tables in Appendix C either, to save space).

All factorial predictors were contrast-coded. Since switching was under the participants' control, we did not have equal cell counts in the Mixed context. Therefore, the contrasts for all factors coding the language choices of Switching participants were weighted by the observed cell counts. Self-rated Spoken English Proficiency was treated as a continuous predictor and centred. No data trimming was performed (all responses above 2250 ms occurred after the response deadline and were thus coded as missing; there were no latencies below 300 ms).

We begin by reporting analyses of Switching participants' performance, as these results are a necessary prerequisite for the full assessment of Non-Switching participants' performance. Then we turn to Non-Switching participants to test the key prediction of the cross-person interference view, namely that they should take longer to name pictures in Dutch when they have heard the Switching participant produce English words.

Switching Participants

Our switching participants switched more often in the Mixed block (50%) than those in Gollan and Ferreira (2009) who switched only 25% of the time. On average, they chose to name 42% of the pictures in English. We return to this finding in the Discussion, when we speculate on reasons that made it possible for our participants to switch more often than participants in previous voluntary switching studies. Below, we first report the results of local analyses (i.e., analyses looking at local effects within the Mixed context), and then the results of global analyses (i.e., analyses looking at global effects, comparing the Mixed context to the Pure - Dutch-only and English-only - contexts).

Local costs. Local costs analyses only take into considerations trials from the Mixed context. The main aim of this set of analyses was to test whether Switching participants were slower when naming pictures in English than in Dutch. If so, this would complicate the interpretation of any local switch cost for Non-Switching participants, as this could be due to Non-Switching participants adjusting to their partner's response speed on a trial-by-trial basis. Therefore, this set of analyses is aimed at ruling out one of the two alternative explanations mentioned in the Introduction, namely the adaptation hypothesis. The other alternative explanation (the unpredictability hypothesis) will be addressed later, in the section looking at local costs for Non-Switching participants.

The first predictor we entered into the model was Language (English vs. Dutch), meaning the language chosen by the Switching participant on the current trial (trial n). We expected Switching participants to show longer naming latencies on Dutch than on English trials (reversed language dominance; Gollan & Ferreira, 2009). For completeness, we also included a second predictor, Language n-2, which is the language chosen by the Switching participant on his or her previous turn (trial n-2), although we did not have specific predictions about it having an effect (usually local costs are evaluated with regard to only the immediately preceding response in language switching studies). We did not include the language spoken on the immediately preceding trial (trial n-1), because due to our design Dutch was always spoken on this trial (by the Non-Switching participant). Finally, we also included the Switching participant's self-rated spoken English proficiency and Frequency (Low vs. High) of the picture name to be produced on the current trial, as further control variables.

Most importantly, Switching participants were no slower when they chose to name in English (901 ms) than when they chose to name in Dutch (886 ms) in the Mixed context ($t<|1|$), and they were also no more likely to produce an incorrect response (they were 90.1% correct in English and 93.5% correct in Dutch; log-odds $B = -1.81$, $SE = 1.54$, $z=-1.18$; Table 2). This is important because it means that any local switch costs for Non-Switching participants could not be due to Non-Switching participants adapting to Switching participants' response speed (which rules out the adaptation hypothesis in relation to local switch costs). Note that in fact we were expecting Switching participants to be slower when naming in Dutch than when naming in English, but we did not observe reversed language dominance. We return to this finding in the Discussion.

INSERT TABLE 2 ABOUT HERE

Unsurprisingly, Switching participants took longer to name low-frequency than high-frequency items (B = 48 ms, SE = 18 ms, t=2.61), both when using Dutch (high frequency: 856 ms; low frequency: 918 ms) and when using English (high frequency: 885 ms, low frequency: 918 ms; Table 3). Numerically, latencies were shorter when Language n-2 was English (871 ms) than when it was Dutch (905 ms; Table 2). However, the main effect of Language n-2 for naming latencies was not significant (B = -54 ms, SE = 31 ms, t = -1.73), nor did Language n-2 affect accuracy on trial n (|z|<1). There were also no interactions with Proficiency (all |t|'s and |z|'s <1.96). The full model for naming latencies is reported in Table C1, and then full model for accuracy is reported in Table C2.

Global costs.[5] This set of analyses looked at trials from both the Mixed and the Pure language contexts. Similarly to local analyses, the main aim was to rule out the adaptation hypothesis of Non-Switching participants' switch costs, but in this case we focussed on global rather than local costs. Therefore, we tested whether Switching participants took longer to name pictures in Dutch in the Mixed than in the Pure Dutch context, which was expected given previous voluntary language switching studies (Gollan & Ferreira, 2009). The first predictor was Language

[5] Note that global costs for Switching participant compared each pure language context to all trials in the mixed context on which the corresponding language was chosen. For example, all Dutch trials from the mixed context were used, and not just the ones that had been preceded by another Dutch trial on the previous Switching participant's trial (n-2). The motivation for this was two-fold. First, local analyses revealed no effect of Language n-2 within the mixed context. Second, Non-Switching participants were always using Dutch in the Mixed context, so the immediate context was constant for all Switching participant trials.

(i.e., the language spoken by the Switching participant on the current trial, trial n), as in local analyses. In addition, we included the predictor Context (Pure vs. Mixed) capturing the effect of mixing language voluntarily as opposed to naming all pictures in one language. Finally, we included two control variables (as in local analyses): Proficiency and Frequency of the picture name to be produced on the current trial.

Most importantly, there was an interaction between Language and Context for naming latencies (B = 309 ms, SE = 107 ms, t = 2.87). When we analyzed Dutch and English trials separately to resolve the interaction, we found that Switching participants using English had similar naming latencies in the English only (895 ms) and the Mixed (901 ms) context (B=33, SE = 43, t=0.77); i.e., there was no global effect for L2. However, Switching participants using Dutch were slower in the Mixed context (886 ms) than in the Dutch-only (814 ms) context (B=150, SE=41, t=3.70); i.e., there was a global switch cost for L1. This is important because it means that any global switch costs for Non-Switching participants could potentially be due to Non-Switching participants adapting to the slower Dutch naming latencies of Switching participants in the Mixed context. We return to this issue in the Discussion.

Unsurprisingly, Switching participants took longer to name low-frequency (891 ms) than high-frequency (843 ms) items (B = 49 ms, SE = 16 ms, t = 3.10) across all three contexts, and showed a tendency towards being more accurate on high-frequency (91.0 %) than low-frequency (85.7%) items (log-odds B = -0.53, SE = 0.27, z = -1.98; Table 3). More interestingly, they were overall slower in English than in Dutch (B = 86 ms, SE = 24 ms, t = 3.35), and similarly made more errors when naming in English than in Dutch (log-odds B = -1.43, SE = 0.55, z = -2.58); the latter effect was attenuated for more proficient bilinguals, as indicated by a significant Language*Proficiency interaction (log-odds B = 1.20, SE = 0.37, z=3.27). The full model for naming latencies is reported in Table C3 and the full model for accuracy is reported in Table C4.

INSERT TABLE 3 ABOUT HERE

Summary. To summarize, Switching participants were on average about as likely to "stay in" one language as they were to switch to the other language. They were no slower when naming pictures in English than when naming pictures in Dutch in the Mixed context. However, Switching participants experienced global switch costs in naming latencies for L1 (and they experienced neither costs nor benefits for L2). The latter finding means that any global switch costs for Non-Switching participants should be interpreted carefully; however, this concern crucially does not apply to Non-Switching participants' local switch costs.

Non-switching participants

Local costs. These analyses looked only at trials from the Mixed context. They comprise of two sets of analyses. The first looks jointly at trials from the first and second half of the Mixed context, and it is aimed at testing the prediction of the cross-person interference view that there should be local switch costs from passive comprehension to production. The second set of analyses looks only at trials from the second half of the Mixed context, and it is aimed at testing whether Non-Switching participants experienced item-level interference effects.

Local switch costs from passive comprehension to production. The first aim of this first set of analyses was to test whether Non-Switching participants experienced local switch costs from passive comprehension of L2 utterances to production of L1 utterances. In addition, this same set of analyses tested an alternative explanation of the occurrence of such costs, namely that they are due to the unpredictability of a switch to English (unpredictability hypothesis; recall that the adaptation hypothesis has already been addressed by analysing Switching participants' performance).

The first predictor we entered into this first set of analyses was Language n-1 (i.e., the language chosen by the Switching participant on the previous trial: English vs. Dutch). In addition, we entered the language chosen by the Switching participant on the third preceding trial (Language n-3: English vs. Dutch) as a predictor. If local switch cost for Non-Switching participants are due to an "unpredictability" effect, we would expect switch costs (i.e., longer naming latencies after the Switching participants used English than Dutch) to be affected by the Switching participant's previous choice of language (i.e., Language n-3). Although it is unclear what direction this effect would take (i.e., is an English trial more "surprising" after a Dutch trial or after an English trial?), we decided to explore this possibility to help rule out the unpredictability hypothesis as an alternative explanation of the predicted switch cost. (Further analyses aimed at ruling out this explanation are described below.) Finally, the Non-Switching participant self-rated spoken English Proficiency and Frequency (Low vs. High) were also included as controls.

Most importantly, participants took longer to name pictures in Dutch after their partner had used English (803 ms) than after they had used Dutch (783 ms; B = 33 ms, SE = 16 ms, t = 2.12). Interestingly, this local switch cost was larger the higher the Non-Switching participant's spoken English Proficiency (B = 34 ms, SE = 14 ms, t=2.43). This finding supports the prediction of the cross-person interference view: We observed switch costs from passive comprehension to production.

Unsurprisingly, participants took longer to name low- than high-frequency words (B = 65 ms, SE = 25 ms, t=2.55; Table 4), both when their partner had just used Dutch (high frequency: 746 ms; low frequency: 823 ms) and when their partner had just used English (high frequency: 780 ms, low frequency: 830 ms). The language chosen by the Switching participant on trial n-3 did not make any difference (main effect, $|t|<1$; Language n-1*Language n-3, B = 41 ms, SE = 32 ms, t=1.28), although we did observe an interaction between Language n-3 and Proficiency (B = 35 ms, SE = 14 ms, t = 2.50). This interaction was not predicted and given that Language n-3 had otherwise no effect, we will not discuss it further. The full model for naming latencies is reported in Table C5. The proportion of correct responses did not differ depending on frequency, the language chosen by the Switching participant on trial n-1 (see Table 4) or on trial n-3 (all $|z| < 1$), and it was also not affected by the Non-Switching participant's Proficiency (log-odds $B = -0.22$, $SE = 0.14$, $z = -1.61$; see Table C7 for the full model for accuracy).

INSERT TABLE 4 ABOUT HERE

Although the analyses just reported did not suggest that previous language choices by the Switching participant modulated the occurrence of local switch costs for the Non-Switching participant (i.e., there was no main effect of Language n-3, and no interaction between Language n-1 and Language n-3), it is possible that participants are sensitive to more global patterns in the sequence of language choices made by the Switching participant. We tested this by correlating the magnitude of the local switch cost experienced by each Non-Switching participant, with their partner's overall switching rate ($r(22) = .02$, $p = .91$), the total number of English trials their partner produced ($r(22) = .17$, $p = .41$), and the number of trials on which their partner switched to English ($r(22) = .18$, $p = .40$). In all cases, these correlations were very small and not significant. In conclusion, there was no indication that switch costs could be due to the Non-Switching participant being "surprised" by the use of English.

Item-level interference effects. This second set of analyses tested the further prediction of the cross-person interference view that there should be cross-person item-level interference effects, and specifically that Non-Switching participants should take longer to name a picture in Dutch if the same picture had previously been named in English by their partner. Recall that in the second half of the Mixed context, Non-Switching participants named pictures that had already been named by the Switching participants in the first half (and vice versa; see Design). Therefore, it was possible to analyze Non-Switching participants' naming times in the second half as a function of the language chosen by the Switching participant in the first half for a particular picture (we term this factor Same-item SP Language). When we included this factor into the analyses, we found that Non-Switching participants took longer to retrieve the Dutch name of a picture if the Switching participant had previously named it in English (824 ms) than in Dutch (757 ms). In fact, a model including Language n-1, Same-item SP Language, and the control variables Proficiency and Frequency (see Table C6 for the full model) as predictors showed a significant main effect of Same-item SP Language (B = 90 ms, SE = 24 ms, t = 3.73), and no main effect of Language n-1 ($|t| < 1$)[6].

INSERT FIGURE 1 ABOUT HERE

Interestingly, however, we also found a significant 3-way interaction (B = -105 ms, SE = 39ms, t = -2.72). As can be observed in Figure 1, if the Switching participant had named the picture in Dutch (left panel), when the Non-Switching participant named it again in Dutch, he or she experienced a local switch cost, that is longer naming times after an English trial (dashed lines) than a Dutch trial (intact lines), and this cost tended to be larger the higher the English proficiency of the Non-Switching participant. This reflected the pattern observed in the main analyses (Table C5), although the interaction of Proficiency with Language n-1 was not reliable (B = 60 ms, SE = 33, t =1.86). To the contrary, if the Switching participant had named the picture in English in the first half (Figure 1, right panel), when the Non-Switching participant named it in Dutch, he or she experienced a local switch benefit, that is longer naming times after a Dutch (intact lines) than an

[6] Note however, that the main effect of Language n-1 was still significant when we looked only at the first half of the Mixed context (B = 54 ms, SE = 26, t = 2.11), with trials preceded by Dutch (790 ms) faster than trials preceded by English (822 ms).

English trial (dashed lines), and this benefit tended to be larger the higher the proficiency of the Non-Switching participant (although, again the Proficiency * Language n-1 interaction was not fully reliable: B = -70 ms, SE = 37, t = -1.93).

This complex pattern of results was not predicted and therefore should be interpreted with caution. However, it suggests that item-level priming effects were very strong in our experiment, to the extent that they neutralized the local switch cost when the to-be-named item had previously been named in English (at least for participants with relatively high proficiency). Nevertheless, a local switch cost was still present when the to-be-named picture had previously been named in Dutch and, most importantly, it was present in the first half of the Mixed context (see Footnote 5), where item-level effects could not have played a role.

Global costs. This final set of analyses looked at trials from the Pure language contexts and stay trials from the Mixed language context. The main aim of these analyses was to test whether Non-Switching participants took longer to produce Dutch words on stay trials in the Mixed context than in the Dutch-only context (i.e., a global switch cost), as predicted by the cross-person interference view. Even though the presence of a global cost for Switching participants naming in Dutch complicates the interpretation of such global switch costs for Non-Switching participants if they are present (see above), we deemed it important to verify whether they do indeed occur in our data, as they are predicted by the cross-person interference view as well. Therefore, the main predictor we entered in the model was Context (Mixed vs. Dutch-only). In addition, we included Proficiency and Frequency (similarly to local analyses), as controls.

Most interestingly, Non-Switching participants were slower at naming in Dutch when their partner was switching (783 ms) than when their partner was not switching (750 ms; B = 61 ms, SE = 28 ms, t = 2.16); i.e., there was a global switch cost on naming latencies. This global switch cost was not modulated by Proficiency (|t|<1). See Table C8 for the full model for naming latencies. Context had no effect on error rates, neither on its own (|z|<1), nor in interaction with proficiency (log-odds B = -0.66, SE = 0.46, z=-1.44). Non-Switching participants were 89.0% accurate in the Mixed context compared to 92.6% accurate in the Dutch-only context. See Table C9 for the full accuracy model. Unsurprisingly, Non-Switching participants were slower naming low-frequency than high-frequency items (B = 119 ms, SE = 40 ms, t = 2.96), and also made more errors when naming low-frequency than high-frequency items (log-odds B = -1.04, SE = 0.32, z = -3.24); these effects were present across contexts as shown in Table 4.

Summary. Summarizing, Non-Switching participants named pictures in Dutch (L1) more slowly after their partner had just named in English (L2) than after they had just named in Dutch (i.e., a local switch cost in naming latencies), particularly if they were proficient in English. There was no evidence that local switch costs were related to English being unexpected and “surprising”, so the unpredictability hypothesis was not supported as an alternative interpretation of the local switch cost. Moreover, the local switch cost was not due to Non-Switching participants adapting to Switching participants’ speed of naming (the adaptation hypothesis), as Switching participants were in fact no slower on English than on Dutch trials in the Mixed context. In the second half of the Mixed context naming latencies were longer for items that the Switching participant had previously named in English, suggesting that strong item-level interference effects were at play, and even that they might have neutralized local costs on a subset of participants and trials. Importantly, though, the local switch cost was reliable in the first half of the Mixed context. Finally, Non-Switching participants were slower when naming in Dutch if their partner could switch (Mixed context) than if their partner could not switch (Dutch-only context), but this global switch cost could also be explained by the fact that Switching participants were slower naming in Dutch in the Mixed than in Dutch-only context (the adaptation hypothesis).

Discussion

This study investigated the effects of one speaker's language choices on the production of another speaker's utterances. The main contribution of this study is the finding that bilinguals who speak only in their L1 experience switch costs when listening to bilinguals who switch voluntarily between their L1 and their L2. This suggests that the mechanisms underlying language choices are shared between comprehension and production, and that bottom-up factors contribute to language selection in production even when speakers use only one language, and therefore could exert top-down inhibition on the non-target language. Below, we first discuss the implications for theories of language control and then briefly compare our findings to previous research on voluntary language switching.

Mechanisms of cross-person, cross-language interference

In the Mixed context, Non-Switching participants listened to Switching participants, who switched between Dutch and English. Hence, Non-Switching participants comprehended some English lexical items, which we assume activated the English language node in their mental lexicon (Van Heuven & Dijkstra, 2010). This node would compete with the Dutch language node and inhibit lexical items linked to the Dutch language node, therefore interfering with subsequent retrieval of Dutch lexical items. This explanation assumes that the language nodes are modality-independent (Grainger et al., 2010; see also Hartsuiker et al., 2004), an assumption that is supported by Peeters et al.'s (2014) finding of switch costs from reading words to naming pictures. Our study confirms their findings and extends them by showing switch costs from listening to L2 words voluntarily produced by one's partner in a joint naming tasks (i.e., in a situation that more closely approximates bilingual dialogue).

Importantly, our participants did not perform any explicit task with the words their partner produced, whereas Peeters et al.'s participants responded to visually presented words in either a language identification or a semantic categorization task. Therefore, our findings suggest the existence of switch costs not only in the absence of explicit language cues and with a fixed response language (as Peeters et al., 2014 already showed), but also when speakers produce an L1 lexical item after passive comprehension of an L2 lexical item. Unlike Peeters et al's study, our findings are not consistent with the within-person selection view, and instead support the cross-person interference view. Specifically, they show that endogenous and exogenous factors can both affect language selection processes, in accordance with the BIA model (Grainger et al., 2010).

The additional activation received by the English language node in the Mixed context can also explain the presence of global switch costs, that is the fact that Non-Switching participants were slower when naming in Dutch if their partner could switch (Mixed context) than if their partner could not switch (Dutch-only context). Note, however, that alternative interpretations of the latter finding are possible. Switching participants were overall slower in the Mixed than in the Dutch-only context, and Non-Switching participants could have been primed to be similarly slower, as predicted by the adaptation hypothesis. One way in which this adaptation could have taken place is if the Switching participant's speed induced the Non-Switching participant to change his or her response time criterion (see Lupker, Kinoshita, Coltheart, & Taylor, 2003).

However, Switching participants were equally fast when they named in Dutch as when they named in English within the Mixed context, and it is therefore unlikely that Non-Switching participants were primed (on a trial-by-trial basis) by their partner's speed of response. In addition, local switch costs were larger the higher the Non-Switching participant's English spoken proficiency. It is plausible that the English node underwent stronger activation in Non-Switching participants who were more proficient in English, and therefore interfered more with the Dutch node. It is hard to see how an interpretation in terms of adaptation might account for this interaction with proficiency. Interestingly, note that the local switch costs we observed did not correlate with the Switching participant's switching rate (nor with how often they used English overall) and was not affected by the Switching participant's choice on trial *n-3*, suggesting that they cannot be explained by the "unpredictability" of English in this paradigm. In fact, Switching participants used English almost as often as Dutch overall (i.e., on 42% of the trials).

Moreover, we also found evidence that local switch costs are influenced by item-level interference (in combination with proficiency). We propose that Non-Switching participants stored memory associations between the concept depicted in a given picture and the language chosen by the Switching participant. This means that when the Switching participant named the picture of, say, a bird in English in the first half of the experimental session, an association was formed between the concept BIRD/VOGEL and the English node in the Non-Switching participant mental lexicon. When the same picture appeared again (in the second half of the session), and the Non-Switching participants prepared to name it in Dutch, conceptual processing (i.e., accessing the concept BIRD/VOGEL) led to higher activation of the English node compared to when the same picture had previously been named in Dutch by the Switching participant, therefore slowing down retrieval of the Dutch name (*vogel*) via inhibition. If this naming event took place just after a Switching participant Dutch trial, this additional difficulty could have counteracted the benefit associated with a stay trial. Conversely, if the naming event took place after a Switching participant English trial, activation of the English node during comprehension of the Switching participant's response might have additionally facilitated retrieval of the concept BIRD/VOGEL during subsequent production, due to the established memory association. We speculate this could have been sufficient to neutralize the cost of the local language switch on naming latencies, and possibly even reverse it for highly proficient bilinguals.

The proposal that item-level interference operated mainly via modulation of conceptual rather than lexical processing is consistent with previous findings on cross-language repetition effects (Hernandez & Reyes, 2002). It is possible that temporary associations between concepts and language nodes could be instrumental in keeping track of another's language preferences in bilingual conversations. It is known that associations between stimuli and responses can interact with switch costs in non-linguistic task switching (e.g., Demanet, Verbruggen, Liefooghe, & Vandierendonck, 2010). Indeed, Waszak, Hommel, and Allport (2003) argued that switch costs are in large part attributable to stimulus-task associations, so that stimuli associated with more than one task are more likely to lead to large switch costs. However, we are not aware of any previous demonstration of similar item-level bottom-up effects in the language switching literature.

Switching voluntarily in a non-switching context

Interestingly, we replicated Gollan and Ferreira's (2009) and Gollan et al.'s (2014) results only partially. Based on their findings, we expected bilinguals who switch voluntarily to switch around 25% of the time and to exhibit a switching profile characterized by more stay than switch trials in L1, and more switch than stay trials in L2. Although most of our Switching participants exhibited this pattern (see Appendix B, Table B2), they switched much more frequently than bilinguals in previous studies (in fact, they switched about half of the time). This was somewhat surprising, particularly given that their partner was always using Dutch, which could have conceivably made it harder for them to switch to English (hearing Dutch could raise the activation of Dutch nodes in the Switching participant's mental lexicon, which should have in turn interfered with the selection of English nodes in the Mixed context).

It must be noted that, unlike Gollan and Ferreira (2009) and Gollan et al. (2014), we familiarized our participants with the pictures' L2 names, and we also stressed the importance of using L2 for "at least some" of the pictures. It is possible that these two aspects of our procedure made the selection of L2 names somewhat more likely despite the lack of explicit instructions to use L2 as often as L1. Interestingly, Gollan and Ferreira (2009) also report an experiment in which they asked bilinguals to "name about half of the pictures in Spanish and half in English" (p. 650).

With those instructions, participants managed to switch language 52% of the time, which is highly comparable to our experiment.

Recall that we expected Switching participants to take longer to name in L1 than in L2 within the mixed block (i.e., reversed language dominance). This was not the case; in fact, Switching participants were no slower in L1 than in L2 within the mixed block. Note that Gollan and Ferreira (2009) observed reversed language dominance in both Experiment 1 and Experiment 2 (i.e., regardless of the instructions given to participants), therefore it is unlikely that differences in instructions might account for this difference between our study and theirs. Interestingly, Gollan et al. (2014, Experiment 2) also reported similar naming latencies for L1 and L2 within the mixed block in an experiment in which picture-name availability was increased (by repeating a small set of pictures). It is possible that familiarizing participants with the picture names at the start of the session, which will have also raised their availability, led to similar findings in our case.

Further, recall that we expected Switching participants to show a global switch cost for L1, that is longer naming times in Dutch in the Mixed than in the Dutch-only context. This prediction was confirmed. We also found no global effects for L2. This pattern of global effects resembles very closely what Gollan and Ferreira (2009) found in their Experiment 2, where they asked participants to switch at least half of the time. It suggests that bilinguals who switch voluntarily apply some inhibition to the L1 lexicon throughout the mixed block, and not only on L2 trials, and that our Switching participants did not just use L2 for very easy lexical items in the mixed block (which would have predicted a global switch benefit for L2). Indeed, they named about as many low-frequency items (205) in English as they did high-frequency items (220) within the mixed block (Table 3).

Finally, Switching participants were no slower naming in a given language if they had used a different language on their previous trial (n-2) than if they had used the same language. Although one should be careful to interpret this effect in the same way as local effects in solo language switching tasks (since the immediate local context was always a Dutch word produced by the Non-Switching participant), this finding resembles the lack of switch costs observed by Gollan and Ferreira (2009) in their Experiment 2. They (p. 652) offered a speculative account of this unusual result, which we think could apply to our findings as well. They suggested that in an effort to follow the instructions bilinguals tried to retrieve L2 names for most items, including many that they eventually named in L1 after failing to retrieve the L2 name. Such failures would presumably have been more likely after an L1 trial than after an L2 trial, with the result that naming latencies on L1 stay trials would have been inflated. Consistent with this explanation, Dutch (L1) trials showed a trend towards a *stay* cost in our experiment, whereas English (L2) trials actually showed the more usual switch cost (similar trends were also present in Gollan and Ferreira's Experiment 2).

In sum, our findings for Switching participants indicate that when bilinguals are left free to choose between L1 and L2 on any given trial, but are also encouraged to use L2 at least some time, they can behave very similarly to bilinguals who are explicitly instructed to use L2 as often as L1. This is interesting as it shows that a pattern of weak global inhibition (and possibly even lack of local switch costs) is not restricted to artificial laboratory tasks. We argue this further supports the hypothesis that both top-down goals and bottom-up availability are crucial determinants of bilinguals' language choices (Gollan & Ferreira, 2009; Grainger et al., 2010).

Conclusion

Passive listening to L2 words produced by another speaker in a joint task situation leads to switch costs in subsequent L1 production. Thus, we conclude that language nodes must be shared between comprehension and production and, further, that bottom-up activation and top-down inhibition are equally implicated in determining naming latencies in production. This contrasts with the view that top-down factors take precedence in production, and instead suggests that a complex interplay of top-down goals and bottom-up availability underlies the language choices made by bilingual speakers.

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Appendix A

Experimental items.

Table A1

Names of the pictured items used in this study.

High Frequency					
List 1		List 2		List 3	
English	Dutch	English	Dutch	English	Dutch
airplane	vliegtuig	belt	riem	basket	mand
bottle	fles	bicycle	fiets	carrot	wortel
box	doos	bowl	kom	candle	kaars
button	knoop	potato	aardappel	coat	jas
car	auto	bag	zak	curtains	gordijn
chain	ketting	drum	trommel	dresser	kast
chair	stoel	chicken	kip	duck	eend
cloud	wolk	sweater	trui	eye	oog
glasses	bril	flower	bloem	knife	mes
gun	geweer	girl	meisje	leg	been
bird	vogel	desk	bureau	mountain	berg
lock	slot	key	sleutel	pillow	kussen
mirror	spiegel	letter	brief	plate	bord
pig	varken	picture	schilderij	rabbit	konijn
cage	kooi	smoke	rook	rock	steen
woman	vrouw	snake	slang	rope	touw
roof	dak	stairs	trap	witch	heks
skirt	rok	tree	boom	bucket	emmer
spoon	lepel	feather	veer	can	blik
tail	staart	wall	muur	leaf	blad
doll	pop	city	stad	horse	paard
window	raam	dog	hond	shirt	hemd
Low Frequency					

List 1		List 2		List 3	
English	Dutch	English	Dutch	English	Dutch
boy	jongen	alarm clock	wekker	bat	vleermuis
bug	kever	barrel	ton	onion	ajuin
camera	fototoestel	binoculars	verrekijker	globe	wereldbol
fireman	brandweerman	bow	strik	hippo	nijlpaard
glove	handschoen	heel	hak	kite	vlieger
horn	toeter	corn	mais	lighthouse	vuurtoren
snail	slak	deer	hert	lightswitch	schakelaar
lobster	kreeft	fan	ventilator	mushroom	paddestoel
mailbox	brievenbus	frog	kikker	paintbrush	penseel
needle	spuit	lizard	hagedis	butterfly	vlinder
ostrich	struisvogel	whale	walvis	pineapple	ananas
scarf	sjaal	hose	tuinslang	parrot	papegaai
rhinoceros	neushoorn	iron	strijkijzer	pencil	potlood
shark	haai	ant	mier	chimney	schoorsteen
stamp	postzegel	cake	taart	scissors	schaar
tie	das	seal	zeehond	slingshot	katapult
arrow	pijl	strawberry	aardbei	tape	cassette
turtle	schildpad	wizard	tovenaar	lemon	citroen
umbrella	paraplu	swing	schommel	well	waterput
dentist	tandarts	toaster	broodrooster	sock	kous
squirrel	eekhoorn	match	lucifer	wheelchair	rolstoel
pants	broek	zipper	rits	ruler	lat

Note. The upper part of the table lists items with high-frequency Dutch names; items with low frequency Dutch names are reported in the lower part of the table. Dutch and English names are reported. Items were subdivided into three lists of equal frequency (see main text for details).

Appendix B

English language profile for Non-Switching and Switching Participants.

Table B1

L2 (English) profile for biliguals who took part in this study.

	Speaker's role			
	Non-Switching		Switching	
	M	SD	M	SD
English Age of acquisition	10.4	3.1	11.7	3.0
English spoken proficiency (self-rated)	7.1	1.3	7.5	0.9
English spoken comprehension (self-rated)	8.4[a]	0.9	8.2[b]	1.1
English reading comprehension (self-rated)	8.0	1.4	8.2	0.7
% current average exposure to English	19.3	12.4	25.1	14.6
% time spent reading in English	37.0	33.2	36.7	26.7
% time spent speaking in English	17.1	24.2	16.5	16.9

Note. Average age of acquisition for English (years); average self-rated English spoken proficiency, spoken comprehension proficiency, and reading comprehesion proficiency (on a scale from 0, *none*, to 10, *perfect*); average current exposure to English (percentage out of 100), and average time currently spent speaking English and reading English (percentages out of a 100). For all measures we report means (M) and standard deviations (SD), separately for Non-Switching participants and Switching participants. All measures are based on the Dutch version of LEAP-Q.

[a] The values for two participants were missing; they were replaced with the group mean.[b] The value for one participant was missing; it was replaced with the group mean.

Individual language mixing patterns (Switching participants).

We followed Gollan & Ferreira's (2009) classification of language mixing types. The matrix language was defined as the language that was used at least 14% more often than the other language throughout the Mixed context. Mixing types were defined in terms of whether switch trials were more or less frequent than stay trials in either or both languages. Following these definitions, the most common mixing type (see Table B2) was "bail out of L2" (i.e., more stay-in-Dutch trials than switch-into-Dutch trials, and conversely less stay-in-English trials than switch-into-English trials).

Table B2

Number of Switching participants displaying each of four language mixing types, as a function of their chosen matrix language.

	Matrix Language		
Mixing type	L1 (Dutch)	L2 (English)	None
Switch ≥ Stay in both languages	5	0	3
Bail out of L2 (Stay>Switch only in L1)	11	0	0
Bail out of L1 (Stay>Switch only in L2)	0	1	1
Stay > Switch in both languages	0	0	3

Note. For a definition of what constitutes the matrix language, see text. For a classification of language mixing types, we refer the reader to the text and to Gollan and Ferreira (2009).

Appendix C

Linear mixed-effects analyses

To save space, we report only those fixed-effect estimates with associated |z| or |t| greater than 1. We also report estimates of the variance explained by the random effects. (p) stands for a random effect by participants; (i) stands for a random effect by items. We refer the reader to the main text (Results section) for definitions of all predictors used in these analyses.

Switching participants (SP)

Table C1

Linear mixed-effect model with normal link function, fitted to naming latencies of Switching participants within the Mixed context (local analyses).

Predictor	Estimate	SE	t	Random effect variance
Intercept	888	21	41.47	(p) 9220; (i) 3479
Frequency	48	18	2.61	(p) 1002
Language n-2	-54	31	-1.73	(p) 2313; (i) 11706
Proficiency	-42	23	-1.85	NA
Frequency * Language n-2	113	58	1.94	NA
Language n-2 * Proficiency	37	32	1.15	NA
Frequency*Language n-2* Proficiency	-115	60	-1.91	NA
Frequency*Language n-	-321	246	-1.31	NA

2*Language*Proficiency

Note. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Language (reference level: Dutch), Language n-2 (reference level: Dutch) and all interactions. Random effects by participants: intercept, Frequency, Language, Language n-2. Random effects by items: intercept, Language, Language n-2.

Table C2

Linear mixed-effect model with logistic link function, fitted to accuracy data of Switching participants within the Mixed context (local analyses).

Predictor	Estimate	SE	z	Random effect variance
Intercept	3.49	0.40	8.68	(p) 0.70; (i) 1.36
Language	-1.81	1.54	-1.18	(p) 0.07; (i) 2.72
Proficiency	-0.33	0.26	-1.27	NA
Language n-2 * Proficiency	-0.99	0.72	-1.38	NA
Language * Frequency	2.54	1.33	1.91	NA
Proficiency * Frequency	0.37	0.34	1.08	NA
Language * Language n-2 * Frequency	6.36	5.23	1.22	NA
Language * Proficiency* Frequency	-1.75	1.35	-1.29	NA

Language n-2 * Proficiency * Frequency	1.92	1.44	1.34	NA
Language*Language n-2 *Proficiency*Frequency	-10.87	5.58	-1.95	NA

Note. Inaccurate responses were coded as 0, accurate responses as 1. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Language (reference level: Dutch), Language n-2 (reference level: Dutch) and all interactions. Random effects by participants: intercept, Frequency, Language, Language n-2. Random effects by items: intercept, Language, Language n-2.

Table C3

Linear mixed-effect model with normal link function, fitted to naming latencies of Switching participants across the Mixed context and the Pure (Dutch-only and English-only) contexts (global analyses).

Predictor	Estimate	SE	t	Random effect variance
Intercept	881	18	49.35	(p) 6292; (i) 4428
Frequency	49	16	3.10	(p) 469
Context (Pure vs. Mixed)	-68	26	-2.56	(p) 10133; (i) 49
Language (English vs. Dutch)	86	24	3.35	(p) 4886
Proficiency	-36	18	-1.94	NA
Context * Language	309	107	2.87	(p) 167220

Frequency * Context * Proficiency	-37	36	-1.03	NA
Context * Language * Proficiency	-142	118	-1.21	NA
Frequency*Context*Language*Proficiency	-225	147	-1.53	NA

Note. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Language (reference level: Dutch), Context (reference level: Mixed) and all interactions. Random effects by participants: intercept, Frequency, Language, Context, Language*Context. Random effects by items: intercept, Context.

Table C4

Linear mixed-effect model with logistic link function, fitted to accuracy data of Switching participants from the Mixed context and the Pure (Dutch-only and English-only) contexts (global analyses).

Predictor	Estimate	SE	z	Random effect variance
Intercept	2.94	0.20	14.99	(p) 0.33; (i) 1.11
Frequency (Low vs. High)	-0.53	0.27	-1.98	(p) 0.16
Context (Pure vs. Mixed)	-0.89	0.68	-1.32	(p) 2.76; (i) 1.24
Language (English vs. Dutch)	-1.43	0.55	-2.58	(p) 0.51; (i) 3.08
Context * Frequency	-1.15	0.73	-1.59	NA
Language * Proficiency	1.20	0.37	3.27	NA
Frequency*Context*Language	-5.20	2.77	-1.88	NA

Frequency*Context*Proficiency	-0.80	0.72	-1.11	NA
Frequency * Language * Proficiency	-0.88	0.64	-1.39	NA
Context*Language*Proficiency	2.46	1.66	1.48	NA

Note. Inaccurate responses were coded as 0, accurate responses as 1. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Language (reference level: Dutch), Context (reference level: Mixed) and all interactions. Random effects by participants: intercept, Frequency, Language, Context, Language*Context. Random effects by items: intercept, Context, Language, Language*Context.

Non-Switching Participants (NSP)

Table C5

Linear mixed-effect model with normal link function, fitted to naming latencies of Non-Switching participants within the Mixed context (local analyses).

Predictor	Estimate	SE	t	Random effect variance
Intercept	797	22	35.43	(p) 9268; (i) 6550
Frequency	65	25	2.55	(p) 5395; (i) NA
Language n-1	33	16	2.12	(p) 119; (i) 1
Proficiency	-33	19	-1.74	NA
Language n-1 * Language n-3	41	32	1.28	NA
Language n-1 * Proficiency	34	14	2.43	NA

Language n-3 * Proficiency	35	14	2.50	NA
Frequency*Language n-1 *Language n-3	-84	63	-1.34	NA
Frequency*Language n-1 *Proficiency	49	28	1.77	NA
Frequency*Language n-1*Language n-3*Proficiency	-100	58	-1.73	NA

Note. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Language n-1 (reference level: Dutch), Language n-3 (reference level: Dutch) and all interactions. Random effects by participants: intercept, Frequency, Language n-1, Language n-3. Random effects by items: intercept, Language n-1, Language n-3.

Table C6

Linear mixed-effect model with normal link function, fitted to naming latencies of Non-Switching participants within the second half of the Mixed context (local analyses, looking specifically at item-level effects).

Predictor	Estimate	SE	t	Random effect variance
Intercept	789	24	32.26	(p) 10832; (i) 4839
Frequency	54	25	2.13	(p) 3140
SP Same-item Language	90	24	3.73	(p) 1013; (i) 15731
Frequency * Proficiency	22	21	1.04	NA
Frequency * Sp Same-item language * Proficiency	45	39	1.15	NA
Language n-1 * SP Same-item Language *	-105	39	-2.72	NA

Proficiency				
Frequency*Language n-1 * SP Same-item Language * Proficiency	-80	77	-1.03	NA

Note. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Language n-1 (reference level: Dutch), SP Same-item Language (reference level: Dutch) and all interactions. Random effects by participants: intercept, Frequency, Language n-1, SP Same-item Language. Random effects by items: intercept, Language n-1, SP Same-item Language.

Table C7

Linear mixed-effect model with logistic link function, fitted to accuracy data of Non-Switching participants within the Mixed context (local analyses).

Predictor	Estimate	SE	z	Random effect variance
Intercept	2.53	0.24	10.43	(p) 0.20; (i) 1.10
Proficiency	-0.22	0.14	-1.61	NA

Note. Inaccurate responses were coded as 0, accurate responses as 1. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Language n-1 (reference level: Dutch), Language n-3 (reference level: Dutch) and all interactions. Random effects by participants: intercept, Frequency, Language n-1, Language n-3. Random effects by items: intercept, Language n-1, Language n-3.

Table C8

Linear mixed-effect model with normal link function, fitted to naming latencies of Non-Switching participants across the Mixed context and the Pure (Dutch-only) context (global analyses).

Predictor	Estimate	SE	t	Random effect variance
Intercept	763	21	37.15	(p) 8379; (i) 3742
Frequency	119	40	2.96	(p) 15591
Context (MIxed vs. Dutch only)	61	28	2.16	(p) 6353; (i) 1377
Proficiency	-42	17	-2.42	NA

Note. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Context (reference level: Dutch-only), and all interactions. Random effects by participants: intercept, Frequency, Context. Random effects by items: intercept, Context.

Table C9

Linear mixed-effect model with logistic link function, fitted to accuracy data of Non-Switching participants across the Mixed context and the Pure (Dutch-only) context (global analyses).

Predictor	Estimate	SE	z	Random effect variance
Intercept	2.97	0.19	15.37	(p) 0.01; (i) 1.07
Frequency	-1.04	0.32	-3.24	(p) 0.30
Context * Proficiency	-0.66	0.46	-1.44	NA

Note. Inaccurate responses were coded as 0, accurate responses as 1. Fixed-effect predictors: Frequency (reference level: High), Proficiency, Context (reference level: Dutch-only), and all interactions. Random effects by participants: intercept, Frequency, Context. Random effects by items: intercept, Context.